



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re Application of:
Kranz, et al.

Serial No.: 10/015,433

Confirmation No.: 5742

Filed: December 12, 2001

For: Method and Apparatus for
Cleaning Substrates

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Group Art Unit: 1765

Examiner: Binh X. Tran

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# APPEAL BRIEF

Applicants submit this Appeal Brief to the Board of Patent Appeals and Interferences on appeal from the decision of the Examiner of Group Art Unit 1765, dated November 10, 2003, finally rejecting claims 1-5, 7-11, and 32. Please charge the fee of \$330.00 for filing this brief to Deposit Account No. 20-0782/AMAT/5318/KMT. Three copies of this brief are submitted for use by the Board.

## Real Party in Interest

The present application has been assigned to Applied Materials, Inc., 3050 Bowers Avenue, Santa Clara, California 95054.

### **Related Appeals and Interferences**

Appellant asserts that no other appeals or interferences are known to the Appellant, the Appellant's legal representative, or assignee which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

### **Status of Claims**

Claims 1-5, 7-11, 18, and 32 are pending in the application. Claims 1-31 were originally presented in the application, and claims 1-5, 7-11, and 18 were subsequently amended. Claims 6, 12-17, and 19-31 have been canceled. Claim 32 was added by amendment before the Final Office Action dated November 10, 2003. Claim 18 has been indicated to be allowable. Claims 1-5, 7-11, and 32 stand rejected in view of several references as discussed below. The rejection of claims 1-5, 7-11, and 32 is appealed. The pending claims are shown in the attached Appendix.

### **Status of Amendments**

Amendments to claims 8 and 11 and cancellation of claims 12-17 and 19-31 were proposed after the final rejection. The amendments to claims 8 and 11 and the cancellation of claims 12-17 and 19-31 were entered. Arguments presented after final rejection were not accepted by the Examiner.

### **Summary of Invention**

The present invention generally provides a method and apparatus for pre-cleaning apertures (612 in Figure 6) on a substrate (600 in Figure 6). The pre-cleaning method may be used to remove contaminants and native oxides (604 in Figure 6) from the substrate (paragraph [0044]). The pre-cleaning method includes cooling the substrate to a temperature of 100 degrees Celsius or less (paragraph [0010]). The substrate is electrostatically chucked to a substrate support in a chamber, and backside gas may be applied to the substrate to cool the substrate (paragraph [0043], 504-508 in Figure 5). The substrate may also be cooled with a thermoelectric device (362 in Figure 3) in the substrate support (304 in Figure 3) and/or by flowing a heat transfer fluid (368 in Figure 3) through the substrate support member (paragraph [0042]).

After the substrate is cooled, the substrate is pre-cleaned with a plasma formed from a processing gas. In one aspect, the processing gas is a non-reactive gas. In another aspect, the processing gas is a mixture of a non-reactive gas and a reducing or reactive gas. The non-reactive gas may be helium, argon, or nitrogen. The reactive gas may be hydrogen, oxygen, or a fluorine containing gas (paragraphs [0044], [0045], 510 in Figure 5). The temperature of the substrate during the pre-cleaning is controlled to prevent agglomeration of sputtered material on the sidewalls of the aperture being cleaned (paragraph [0048]).

### **Issues Presented**

1. Whether the Examiner erred in rejecting claims 1-3, 5, and 32 under 35 U.S.C § 102(e) as being unpatentable over *Hills, et al.*
2. Whether the Examiner erred in rejecting claim 4 under 35 U.S.C § 103(a) as being unpatentable over *Hills, et al.* in view of *Maxwell, et al.*
3. Whether the Examiner erred in rejecting claims 7-9 under 35 U.S.C § 103(a) as being unpatentable over *Hills, et al.* in view of *Subrahmanyam, et al.*
4. Whether the Examiner erred in rejecting claims 10 and 11 under 35 U.S.C § 102(e) as being unpatentable over *Chou, et al.*

### **Grouping of Claims**

Pending claims 1-5, 7-11, and 32 do not stand or fall together for all arguments presented by Applicants. Applicants' first argument relates to the first issue for claims 1-3, 5, and 32, and claim 1 is representative of the claims. Applicants' second argument relates to the second issue for claim 4, and claim 4 is representative of the claims. Applicants' third argument relates to the third issue for claims 7-9, and claim 7 is representative of the claims. Applicants' fourth argument relates to the fourth issue for claims 10 and 11, and claim 10 is representative of the claims.

## ARGUMENT

**I. THE EXAMINER ERRED IN REJECTING CLAIMS 1-3, 5, AND 32 BECAUSE *HILLS, ET AL.* FAILS TO TEACH, SHOW, OR SUGGEST A METHOD FOR PRE-CLEANING APERTURES ON A SUBSTRATE COMPRISING EXPOSING THE SUBSTRATE TO A PRE-CLEAN PROCESS COMPRISING FORMING A PLASMA FROM A GAS MIXTURE CONSISTING OF A NON-REACTIVE GAS AND A REACTIVE GAS SELECTED FROM THE GROUP CONSISTING OF FLUORINE CONTAINING GASES AND HYDROGEN, AS RECITED IN CLAIM 1.**

Claims 1-3, 5, and 32 stand rejected under 35 U.S.C § 102(e) as being unpatentable over *Hills, et al.* on grounds that *Hills, et al.* teaches a method of pre-cleaning a substrate that includes forming a plasma from a gas mixture consisting of a non-reactive gas and a reactive gas selected from the group consisting of fluorine containing gases and hydrogen.

The Examiner acknowledges that *Hills, et al.* discloses a plasma etching gas mixture including fluorocarbon gas, nitrogen gas, oxygen, an inert carrier gas, and a hydrogen containing additive gas. However, the Examiner asserts that since Applicants use the term “comprising” in the preamble of claim 1, the Examiner reserves the right to interpret any additional gas used in *Hills, et al.* as belonging to other elements not excluded from the claim as a whole. The Examiner states that he interprets any additional gas in *Hills, et al.* to be just another gas mixture co-existing with the same gas mixture claimed by Applicants. Applicants respectfully traverse the rejection.

*Hills, et al.* describes etching an oxide layer with a plasma formed from an etching gas that includes a fluorocarbon gas, N<sub>2</sub>, O<sub>2</sub>, an inert carrier gas, and a hydrogen-containing additive gas (column 2, lines 53-64, column 6, Table 2). *Hills, et al.* describes the gas mixture of the fluorocarbon gas, N<sub>2</sub>, O<sub>2</sub>, an inert carrier gas, and a hydrogen-containing additive gas as an improved etching gas chemistry (602, Figure 6, column 4, lines 51-56).

Applicants agree with the Examiner that claim 1 does not exclude pre-cleaning with other gases, as claim 1 recites a method “comprising” certain elements. According to MPEP § 211.03, “When the phrase “consists of” appears in a clause of the body of a claim, rather than immediately following the preamble, it limits only the element set forth in that clause; other elements are not excluded from the claim as a whole.” Thus, while

claim 1 uses the term “comprising” in the preamble, elements set forth in the “consisting of” clause in the body of the claim are still limited by the “consisting of” language and can not be anticipated by a reference that has a corresponding element that “comprises” but does not “consist of” the components recited in Applicants’ “consisting of” clause.

Applicants respectfully submit that *Hills, et al.*’s description of a gas mixture of a fluorocarbon gas, N<sub>2</sub>, O<sub>2</sub>, an inert carrier gas, and a hydrogen-containing additive gas does not teach or suggest a plasma from a gas mixture consisting of a non-reactive gas and a reactive gas selected from the group consisting of fluorine containing gases and hydrogen. The Examiner improperly ignores the clause “consisting of” in claim 1 when finding that *Hills, et al.*’s etching gas mixture that includes a fluorocarbon gas, N<sub>2</sub>, O<sub>2</sub>, an inert carrier gas, and a hydrogen-containing additive gas corresponds to a first plasma consisting of two of the five gases of the mixture, *i.e.*, an inert carrier gas and a fluorocarbon, as one element corresponding to Applicants’ claim, and to a second plasma consisting of N<sub>2</sub>, O<sub>2</sub>, and a hydrogen-containing additive gas as another element not excluded by Applicants’ claim 1.

*Hills, et al.* does not teach or suggest separating the five components of the etching gas chemistry spatially or temporally such that there is a place in the chamber or a period during the etching process in which a plasma from a gas mixture consisting of a non-reactive gas and a reactive gas selected from the group consisting of fluorine containing gases and hydrogen exists. Therefore, *Hills, et al.* does not provide a plasma from a gas mixture consisting of a non-reactive gas and a reactive gas selected from the group consisting of fluorine containing gases and hydrogen.

Thus, Applicants submit that *Hills, et al.* does not teach, show, or suggest a method for pre-cleaning apertures on a substrate, the method comprising disposing the substrate on a substrate support member in a process chamber, cooling the substrate to a temperature of 100 degrees Celsius or less, and exposing the substrate to a pre-clean process comprising forming a plasma from a gas mixture consisting of a non-reactive gas and a reactive gas selected from the group consisting of fluorine containing gases and hydrogen, as recited in claim 1. Applicants respectfully request withdrawal of the rejection of claim 1 and of claims 2, 3, 5, and 32, which depend thereon.

**II. THE EXAMINER ERRED IN REJECTING CLAIM 4 BECAUSE *HILLS, ET AL.* IN VIEW OF *MAXWELL, ET AL.* FAILS TO TEACH, SHOW, OR SUGGEST A METHOD FOR PRE-CLEANING APERTURES ON A SUBSTRATE COMPRISING EXPOSING THE SUBSTRATE TO A PRE-CLEAN PROCESS COMPRISING FORMING A PLASMA FROM A GAS MIXTURE CONSISTING OF A NON-REACTIVE GAS AND A REACTIVE GAS SELECTED FROM THE GROUP CONSISTING OF FLUORINE CONTAINING GASES AND HYDROGEN, AS RECITED IN CLAIM 1, UPON WHICH CLAIM 4 DEPENDS.**

Claim 4 stands rejected under 35 U.S.C § 103(a) as being unpatentable over *Hills, et al.* in view of *Maxwell, et al.* on grounds that it would have been obvious to use the thermoelectric device of *Maxwell, et al.* in the process of *Hills, et al.* Applicants respectfully traverse the rejection.

As discussed above with respect to Applicants' first argument, *Hills, et al.* does not provide all of the elements of claim 1. Applicants further submit that *Maxwell, et al.* alone, or in combination with *Hills, et al.*, does not teach, show, or suggest a method for pre-cleaning apertures on a substrate, the method comprising disposing the substrate on a substrate support member in a process chamber, cooling the substrate to a temperature of 100 degrees Celsius or less, and exposing the substrate to a pre-clean process comprising forming a plasma from a gas mixture consisting of a non-reactive gas and a reactive gas selected from the group consisting of fluorine containing gases and hydrogen, as recited in claim 1. As claim 4 includes the limitations of claim 1, *Hills, et al.* in view of *Maxwell, et al.* does not provide all of the limitations of claim 4. Applicants respectfully request withdrawal of the rejection of claim 4.

**III. THE EXAMINER ERRED IN REJECTING CLAIMS 7-9 BECAUSE *HILLS, ET AL.* IN VIEW OF *SUBRAHMANYAN, ET AL.* FAILS TO TEACH, SHOW, OR SUGGEST A METHOD FOR PRE-CLEANING APERTURES ON A SUBSTRATE COMPRISING EXPOSING THE SUBSTRATE TO A PRE-CLEAN PROCESS COMPRISING FORMING A PLASMA FROM A GAS MIXTURE CONSISTING OF A NON-REACTIVE GAS AND A REACTIVE GAS SELECTED FROM THE GROUP CONSISTING OF FLUORINE CONTAINING GASES AND HYDROGEN, AS RECITED IN CLAIM 1, UPON WHICH CLAIM 7 DEPENDS.**

Claims 7-9 stand rejected under 35 U.S.C § 103(a) as being unpatentable over *Hills, et al.* in view of *Subrahmanyam, et al.* on grounds that it would have been obvious to modify *Hills, et al.* by etching native copper oxide as described in *Subrahmanyam, et al.* Applicants respectfully traverse the rejection.

As discussed above with respect to Applicants' first argument, *Hills, et al.* does not provide all of the elements of claim 1. Applicants further submit that *Subrahmanyam, et al.* alone, or in combination with *Hills, et al.*, does not teach, show, or suggest a method for pre-cleaning apertures on a substrate, the method comprising disposing the substrate on a substrate support member in a process chamber, cooling the substrate to a temperature of 100 degrees Celsius or less, and exposing the substrate to a pre-clean process comprising forming a plasma from a gas mixture consisting of a non-reactive gas and a reactive gas selected from the group consisting of fluorine containing gases and hydrogen, as recited in claim 1. As claim 7 includes the limitations of claim 1, *Hills, et al.* in view of *Subrahmanyam, et al.* does not provide all of the limitations of claim 7. Applicants respectfully request withdrawal of the rejection of claim 7, and of claims 8-9, which depend thereon.

**IV. THE EXAMINER ERRED IN REJECTING CLAIMS 10 AND 11 BECAUSE *CHOU, ET AL.* FAILS TO TEACH, SHOW, OR SUGGEST A METHOD FOR PRE-CLEANING APERTURES ON A SUBSTRATE COMPRISING EXPOSING THE SUBSTRATE TO A PRE-CLEAN PROCESS COMPRISING FORMING A PLASMA FROM A GAS MIXTURE CONSISTING OF A NON-REACTIVE GAS, AS RECITED IN CLAIM 10.**

Claims 10 and 11 stand rejected under 35 U.S.C § 102(e) as being unpatentable over *Chou, et al.* on grounds that *Chou, et al.* discloses exposing a substrate to a cleaning/etching process comprising a plasma from the gas mixture consisting of a non-reactive gas. The Examiner asserts that as Applicants' claim 10 recites a method "comprising" various elements, he can interpret *Chou, et al.*'s argon, helium, and nitrogen gas as the first plasma consisting of a non-reactive gas and that any additional gas such as oxygen can be interpreted as the "second plasma." Applicants respectfully traverse the rejection.

Applicants submit that while claim 10 uses the term "comprising" in the preamble, elements set forth in the "consisting of" clause in the body of the claim are

still limited by the “consisting of” language and can not be anticipated by a reference that has a corresponding element that “comprises” but does not “consist of” the components recited in Applicants’ “consisting of” clause. *Chou, et al.* describes etching a substrate with a plasma of oxygen, and states that other gases such as argon, helium, and nitrogen may be used along with the oxygen to help stabilize the plasma (column 9, lines 1, 42-43). *Chou, et al.* describes using a non-reactive gas such as argon, helium, or nitrogen only to stabilize the plasma generated from oxygen (column 9, lines 23-43). There is no teaching or suggestion in *Chou, et al.* of a plasma consisting only of a non-reactive gas. There is no teaching or suggestion in *Chou, et al.* of a method of providing the oxygen and the non-reactive gas in the chamber such that a first plasma consisting of non-reactive gas but not oxygen is present in the chamber.

Thus, Applicants submit that *Chou, et al.* does not teach, show, or suggest a method for pre-cleaning apertures on a substrate, the method comprising disposing the substrate on a substrate support member in a process chamber, electrostatically chucking the substrate to the substrate support member, cooling the substrate to less than about 100 degrees Celsius, and exposing the substrate a pre-clean process comprising a plasma formed from a gas mixture consisting of a non-reactive gas, as recited in claim 10. Applicants respectfully request withdrawal of the rejection of claim 10, and of claim 11, which depends thereon.



### Conclusion

In conclusion, *Hills, et al.*, alone or in combination with *Maxwell, et al.* or *Subrahmanyam, et al.*, does not teach, show, or suggest a method for pre-cleaning apertures on a substrate, the method comprising disposing the substrate on a substrate support member in a process chamber, cooling the substrate to a temperature of 100 degrees Celsius or less, and exposing the substrate to a pre-clean process comprising forming a plasma from a gas mixture consisting of a non-reactive gas and a reactive gas selected from the group consisting of fluorine containing gases and hydrogen. Furthermore, *Chou, et al.* does not teach, show, or suggest a method for pre-cleaning apertures on a substrate, the method comprising disposing the substrate on a substrate support member in a process chamber, electrostatically chucking the substrate to the substrate support member, cooling the substrate to less than about 100 degrees Celsius, and exposing the substrate a pre-clean process comprising a plasma formed from a gas mixture consisting of a non-reactive gas. Thus, it is believed that the rejections made by the Examiner should be reversed. Thus, Applicants respectfully request reversal of the rejection and allowance of claims 1-5, 7-11, and 32.

Respectfully submitted,



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## APPENDIX

1. (Previously Presented) A method for pre-cleaning apertures on a substrate, the method comprising:
  - disposing the substrate on a substrate support member in a process chamber;
  - cooling the substrate to a temperature of 100 degrees Celsius or less; and
  - exposing the substrate to a pre-clean process comprising forming a plasma from a gas mixture consisting of a non-reactive gas and a reactive gas selected from the group consisting of fluorine containing gases and hydrogen.
2. (Previously Presented) The method of claim 1, further comprising electrostatically chucking the substrate to the substrate support member.
3. (Previously Presented) The method of claim 1, wherein the cooling the substrate comprises:
  - flowing a gas through the substrate support member to an area between the substrate support member and the substrate.
4. (Previously Presented) The method of claim 1, wherein the cooling the substrate comprises:
  - transferring heat from the substrate through a thermoelectric device.
5. (Previously Presented) The method of claim 1, wherein the cooling the substrate comprises:
  - transferring heat from the substrate through the substrate support member to a heat transfer fluid.
6. (Canceled)
7. (Previously Presented) The method of claim 1, wherein the pre-clean process further comprises:

etching native copper oxide from the substrate.

8. (Previously Presented) The method of claim 7, wherein the pre-clean process further comprises:

inductively coupling about 1 to about 1000 Watts to the plasma; and  
biasing the substrate support member with less than about 300 Watts.

9. (Previously Presented) The method of claim 7, wherein the pre-clean process further comprises:

reducing native oxides or reacting and removing photoresist residue and  
contaminants.

10. (Previously Presented) A method for pre-cleaning apertures on a substrate, the method comprising:

disposing the substrate on a substrate support member in a process chamber;  
electrostatically chucking the substrate to the substrate support member;  
cooling the substrate to less than about 100 degrees Celsius; and  
exposing the substrate a pre-clean process comprising a plasma formed from a  
gas mixture consisting of a non-reactive gas.

11. (Previously Presented) The method of claim 10, wherein the pre-clean process further comprises:

inductively coupling about 1 to about 1000 Watts to the plasma;  
biasing the substrate support member with less than about 300 Watts; and  
regulating the chamber pressure between about 0.5 to about 100 mTorr.

12-17. (Canceled)

18. (Previously Presented) A method for pre-cleaning apertures on a substrate, the method comprising:

disposing the substrate on a substrate support member in a process chamber;

exposing an at least partially exposed copper layer on the substrate to a pre-clean process while maintaining a substrate temperature of less than about 100 degrees Celsius; and

depositing a bulk layer of copper on the at least partially exposed copper layer.

19-31. (Canceled)

32. (Previously Presented) The method of claim 1, wherein the non-reactive gas is selected from the group consisting of argon, nitrogen, and helium.